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BOTANICAL GAZETTE

AUGUST, 1894.

Descriptions of new species of Uredineæ and Ustilagineæ, with remarks on some other species. II.

P. DIETEL.

WITH PLATE XXIX.

Chrysomyxa Arctostaphyli, n. sp.—Sori hypophyllous on red brown spots of about 4^{mm} diameter, arranged into groups, flattened, of irregular outline. Depth of the layers 160–240μ, spore cells oblong, about 18μ in diameter.

On *Arctostaphylos Uva Ursi.* Wisconsin, leg. Davis (no. 921), comm. Ellis.

Chrysomyxa Chiogenis, n. sp.—Spots yellowish or none; sori hypophyllous, scattered. Uredo layers appearing, when fresh, honey colored; uredospores formed in chains, ovate, 22–29 × 15–21μ, with colorless, coarsely verrucose membranes. Teleutosori orange-red, waxy, 95–120μ in depth, spores 8–12μ in diameter.

On *Chiogenes serpyllifolia.* Wisconsin, June, 1893, leg. Davis (no. 6,078), comm. Ellis.

By the dimensions of the spores this species is hardly distinguishable from *Chrysomyxa Pyrolæ* (DC.), but the uredospores on an average are smaller than in the last named species. Yet the sori do not occupy, as in this, uniformly the whole under surface of the leaves. Another difference, worthy of notice although small, consists in the structure of the membranes of the uredospores. In Chr. Chiogenis the tubercles, or, as DeBary has demonstrated, the prominent ends of the more dense staff-like portions of the membrane are thinner than in Chr. Pyrolæ. On the other hand the staff-like structure of the membrane is even more delicate in *Chr. Ledi* (Alb. et Schw.) and *Chr. Rhododendri* (DC.) than in our species under consideration.

Puccinia vulpinoidis D. & H., n. sp.—Hypophyllous, sori small, elliptical to linear. Uredospores obovate or elliptical, pale brownish, echinulate. Teleutosori long covered by the epidermis, afterwards erumpent, black; teleutospores clavate or fusiform, somewhat constricted in the middle, upper cell truncate or attenuated, often obliquely, thickened at the summit, lower cell cuneiform, clear brown, the apex being darker colored, epispore smooth, 40–65 × 14–19 μ. Pedicels persistent, about half the length of the spores.

On *Carex vulpinoidea*. Lafayette, Ind., Nov. 1888, leg. H. L. Bolley.

Puccinia areolata D. & H., n. sp.—Aecidia and teleutosori hypophyllous on pale spots of 1–2.5^{mm} diameter. Aecidia forming small irregular groups, pseudoperidia decaying, white, with torn edges, aecidiospores ovoid, about 25 × 21 μ, with colorless minutely verrucose membranes. Teleutosori scattered, dark brown, punctiform to 1^{mm} in diameter, soon naked, pulverulent. Teleutospores rather different in form and size, mostly elliptical to clavate, apex rounded, surmounted by a large hyaline papilla, lower cell with a similar papilla on the germ-pore beneath the septum, rounded at the base or somewhat narrowed toward it. Central constriction moderate. Epispore beset with minute warts, hardly visible in water, brown; 50–80 × 21–34 μ. Pedicels deciduous, usually short.

On *Caltha biflora*. Skamania co., Wash., Aug. 1888, leg. W. N. Suksdorf.

This is the fourth Puccinia on Caltha, all of which are said to occur in North America. *Puccinia Treleasiana* Pazschke on *C. leptosepala* and our species on C. biflora are exclusively American. *Puccinia Zopfii* Wint. and *P. Calthæ* Lk., both on *C. palustris*, have also a wide distribution in Europe. I have never seen the last named species from America. For comparison we give figures of all four species.—Plate XXIX, figs. 1–4.

Puccinia hyalomitra D. & H., n. sp.—Sori hypophyllous, oblong, 1–5^{mm} long, brown, pulverulent. Spores elliptical, slightly constricted at the septum, rounded at the base, apex with a flat conical hyaline thickening, lower cell provided with a similar lateral thickening, membrane thick (5–6 μ), chestnut brown, smooth, 47–53 × 32–37 μ. Pedicels

colorless, easily detached at their bases with the spores, 100–120μ long.

On *Chrysopsis villosa.* Helena, Mont., April, 1889, leg. F. D. Kelsey.

Puccinia Chloridis mihi in Hedwigia **31:** 290, 1892, is apparently identical with the previously named *Puccinia Chloridis* Speg.

Phragmidium biloculare D. & H., n. sp.—Sori hypophyllous and on the pedicels and stems, on the leaves circular or oblong, often following the principal veins and confluent into long patches, soon naked, pulverulent. Uredosori orange yellow, teleutosori dark brown. Uredospores ovoid or elliptical, 22–30 × 15–23μ, membranes colorless with minute distant papillæ. Teleutospores usually two-celled, seldom three-celled, elliptical, blunt or rounded at both ends, barely constricted or not at all, membranes yellow brown or dirty brown, so transparent as to make recognizable the orange red contents, covered with large tubercles which swell somewhat in water, sometimes nearly smooth, provided with three germ-pores in each cell, 30–44 × 20–28μ, three-celled spores 45–54μ long. Pedicels colorless, to 60μ, detached with the spores.

On *Potentilla gelida.* Chiquash Mts., Skamania co., Wash. Aug. 1892, leg. W. N. Suksdorf (no. 351).

It will seem contradictory that we have placed this fungus in the genus Phragmidium, for the three-celled spores are present only in a very small number, about one per cent. But in many other respects it accords so completely with the typical Phragmidia, that, in placing it in the genus Puccinia, one would separate this species from its nearest allies. We shall discuss particularly this point on another occasion.

Tilletia Elymi D. & H., n. sp.—Spore masses black, destroying the ovaries. Spores globose, dark olive brown, 24–28μ in diameter. Epispore reticulated with ridges 2.6–4μ high and about 3μ apart.

On *Elymus* spec. Skamania co., Wash., Aug. 1886, leg. W. N. Suksdorf.

Tolyposporium Davidsonii D. & H., n. sp.—Spores produced in spherical firm walled galls of about 0.7^{mm} diameter, on the outside and at the bases of the perigonial leaves and the leaflets within the inflorescence. Spore mass powdery, light chocolate brown, discharged by irregular ruptures of the

galls. Spores aggregated in very different manner into balls of 2 to 7 cells or isolated, longish or isodiametric, flattened on the sides of contact, pale, densely verrucose. Dimensions of the spore cells 12–15 × 7–13 μ.

On *Atriplex* spec. Los Angeles, Calif., Sept. 1893, leg. Dr. A. Davidson. This is a very remarkable fungus on account of its peculiar appearance, represented in plate XXIX, fig. 5. The arrangement of the spore cells is a very variable one. In bicellular spores the cells touch each other by their longer sides, or the plane of separation is inclined (figs. 7*a*, 7*b*). In three-celled spores the cells are arranged into a triangle (7*c*) or into a straight line or in an intermediate manner (7*d*). If the spore ball is four-celled, the component cells are situated across in the same plane (7*e*), or may be arranged in a different manner (7*f*). Likewise in aggregates of more than four cells, these may lie in the same plane (7*g*) or form a nearly spherical body (7*h*). More than seven cells in one spore ball have not been observed; the most frequent cases are two to four cells. The spores are produced within small pisiform receptacles walled by a few layers of parenchymatous cells of the host plant. The formation of the spores begins in the center of the galls and gradually proceeds outwards. In the more advanced conditions the interior wall of the cavity is covered with a stratum of hyphæ whose innermost beds are transformed into a gelatinous mass forming the spores (see figs. 6 and 8).

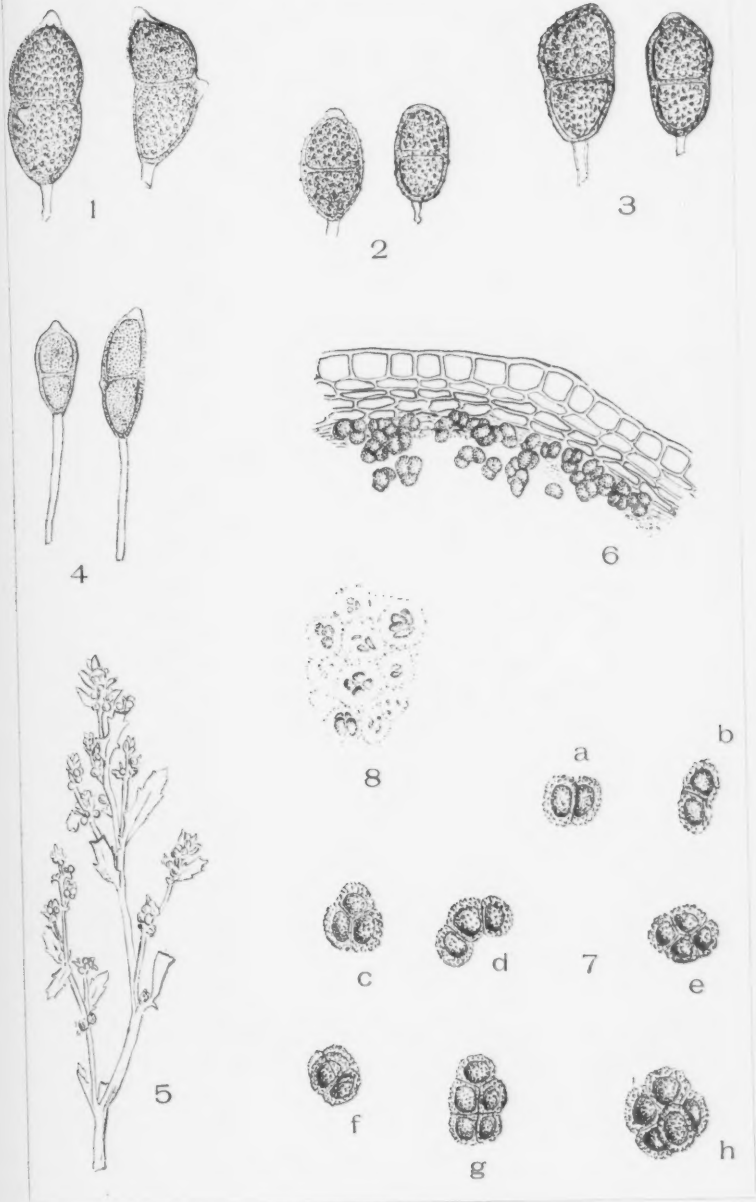
Peronospora phlogina D. & H., n. sp.—Conidiophores erumpent in whitish afterwards dirty flocks from the under surfaces of the leaves, five to seven times bifurcated, the terminal branchlets slightly curved. Conidia ovoid, 26–29 × 16–20 μ, nearly colorless, in masses appearing dirty brownish, smooth. Oospores spherical, 32–48 μ diam., coarsely verrucose, yellow brown.

On *Phlox divaricata.* Decorah, Iowa, June 1888, leg. Holway.

Leipzig, Germany.

EXPLANATION OF PLATE XXIX.

Fig. 1, Puccinia areolata.—Fig. 2, Puccinia Treleasiana.—Fig. 3, Puccinia Zopfii.—Fig. 4, Puccinia Calthæ. ×400.—Figs. 5–8, Tolyposporium Davidsonii.—Fig. 5, A diseased twig of Atriplex (with broken leaves) ×2.—Fig. 6, Part of a section through a gall. ×250.—Fig. 7, Spores. ×500.—Fig. 8, Young spores.



DIETEL on UREDINEÆ, etc.

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James Logan, an early contributor to the doctrine of sex in plants.

JOHN W. HARSHBERGER.

No part of botany has so often engaged the pen of the historian as the doctrine of sexuality in plants, established by Rudolph Jacob Camerarius in his works collected by Johann Mikan, professor of botany in Prague, under the title Opuscula Botanici Argumenti. Before the year 1691, and after that date although to a less extent, the authority of the ancients was still great, for in the books of that time, the views of Aristotle, Empedocles and Theophrastus are constantly quoted in support of one theory or another. Even Camerarius insists that the opinion of the Greek authors on natural history is not opposed to his sexual theory. A perusal of the works of Grew, Ray, and Malpighi show how loath these botanists were to set up their opinions against the scholasticism of the middle ages. A historical retrospect interestingly shows that progress in botany, as in every science, was made spasmodically, and often in an uncertain and indirect way did the leaders in botanical thought break away from the scientific mysticism of the ancients.

The path forward was a long and tortuous one. The philosophical speculations, founded deductively on the hypothetical observation of nature, could only be set aside and a true science created in one way, namely that of experiment. The value of Camerarius's work lies in the fact that he for the first time attempted to solve the question and remove the difficulties which embarrassed the sexual theory by direct experiment. To the scanty knowledge concerning the date palm, the terebinth and the 'malus medici,' as given by Theophrastus, and the untrustworthy observations of Ray and Malpighi, Camerarius added much of value by his careful investigations.

Sachs, in his "History of Botany," after a full discussion of the matter, giving all honor to the scientific spirit of Camerarius, names him as the founder of the doctrine of sexuality in plants, and states further, that the botanists Bradley, Logan, Miller, and Gleditsch, were instrumental in adding much additional experimental proof. The purpose of this paper is

to show how far James Logan, an American and Philadelphian, contributed to lay the foundations of that doctrine which received its true scientific stamp from the hands of Joseph Kölreuter, Conrad Sprengel and Karl Friedrich Gärtner.

Philadelphia at the beginning of the eighteenth century stood for the excellence of science in America. Franklin, Bartram and Logan lived contemporaneously. It is to the little known writings of James Logan, an Irishman, governor of Pennsylvania, that I wish to advert. Sachs mentions him as one of the adherents and a founder of the sexual theory in plants, one of the first to determine by direct experiment the necessity of the pollen (farina) to the fecundation of the ova (ovules). The experiments were made to controvert the statements of M. Geoffroy in Miller's dictionary to the effect that by some experiments on maize, he (M. Geoffroy) was convinced that seeds may grow up to their full size and appear perfect to the eye without being impregnated by the farina (pollen). James Logan states in a letter to Peter Collinson, dated Philadelphia, Nov. 20, 1735, that he had reason to think otherwise.[1] His experiments were undertaken with a definite end in view, to test the truth of M. Geoffroy's statements.

The results of the experiments were given in brief in the letter to Peter Collinson, and later a full account was published in Latin in a work entitled, "Experimenta et Meletemata de Plantarum Generatione, etc., auctore Jacobo Logan, *Judice Supremo, & Praeside Concilii Provinciæ Pensilvaniensis in America.* Lugduni Batavorum. Apud Cornelium Haak 1739," pp. 3–13. (Preface dated Philadelphia 1737.)

Dr. Fothergill, the "J. F." of the English preface, translated the work of 1739 into English. The English version was published in London in 1747 under the title, "Experiments and Considerations on the Generations of Plants, translated from the Original Latin by J. F., London, printed for C. Davis, over against Gray's Inn Gate, Holborn, 1747." The Latin text appeared on one page, and opposite to it, on the other, the English translation. Sachs mentions both of these works, but was unable to consult them in the preparation of his history. Dr. Fothergill's preface to the English edition is worth quoting, as an introduction to Governor Logan's experiments.

[1] Phil. Trans., **34**: 192–195.

"The following essay in Latin was published at Leyden in 1739: It is now translated and reprinted here, that the sentiments contained in it may be submitted to more general consideration. Our author's address in choosing and conducting experiments, and his capacity for the abstrusest researches would doubtless have enabled him to have given to the world ample satisfaction on this intricate subject had he been permitted to prosecute his inquiries. But his country called him [Cincinnatus like] to more important affairs, and kept him constantly engaged in employments more immediately beneficial to society.

"The translator has endeavored to keep close to his author's sense. In point of expression, he fears, he often falls short of the original, the style whereof is nervous, concise and truly Roman. The Latin botanical terms are mostly retained, as we have not yet words in our own tongue to express the various parts of plants and flowers, which the growing science is obliged to describe, and to explain by terms adopted from other languages, etc. J. F."

The experiments, given in the quaint style of the period, speak for themselves.

"As several doubts had formerly occurred to me, in respect to the generation of both plants and animals, when I first heard of the *farina foecundans*, or impregnating male dust, I conceived great hopes that these would be easily solved, and the whole of this intricate affair receive considerable light from the discovery. And as I had long ago observed with surprize, the singular way of growth of our Indian wheat or maize, I judged it, of all plants I had seen, or perhaps of any that nature produces, the most proper one for experiments of this kind. Indian wheat grows to the height of six, eight and sometimes ten feet. At the top of the stalk, it bears a thready tuft or tassel (called by Malpighi muscarium), furnished with apices [anthers] which yield the farina. From the joints of the stalks below, the ears grow out, which are six, eight, ten and sometimes even twelve inches long. These consist of a pretty solid substance, about an inch thick, set quite around with grains regularly disposed in rows, in a very beautiful manner. Generally there are eight such rows, often ten, sometimes twelve, and I once saw sixteen. There are commonly forty grains in each row, more or less; which in their first rudiments, and whilst the stalk they grow upon is

soft and tender may justly be called the ova or eggs. To each ovum, there adheres a white, fine, smooth filament, which excepting that it is hollow, resembles a thread of silk. These filaments are disposed, one by one, in order, betwixt the rows from that end where the ear rises from the stalk to the other, where they creep from under the base, that encloses the ear, and make their appearance, in the open air, in a bundle or skein. Their color in this part is mostly whitish, though sometimes a little yellow, red or purple, according to the nature of the plant they grow from. These filaments, as I formerly suspected are the real styles of the eggs.

"Intending, therefore, to make some experiments on this plant, towards the end of April, I planted four or five grains on hillocks, as is usual in sowing maize, in each corner of a little garden I had in town, which was forty feet wide and eighty feet long. About the beginning of August, when the plants were full grown, and the tufts on the top, and the ears on the stem had acquired their full extent, I cut off these tufts from every plant on one hillock. On another without meddling with the tufts, I gently opened the leaves that covered in the ears, and cut away from some all the styles and then closed the leaves again; from others a quarter part, from others one half, and from others three quarters, and left the rest untouched. I covered another ear, before the skein of styles appeared out of the case, with a piece of very fine, soft muslin, but so loosely, that its growth could not be injured, and whilst the fuzzy texture of the muslin suffered it to receive all the benefit of the sun, air and showers, the farina was effectually secluded. I left the plants on the fourth hillock, as I did these except in the circumstances above mentioned, unmolested till they were fully ripe.

About the beginning of October, when it was time to inquire into the success of my experiments, I made the following observations. In the first hillock, where I had cut off all the tufts, the ears whilst they remained covered with their husks, looked indeed very well, but were small, and felt light when handled; and not one perfect grain to be found in them, except in one large ear, which grew out somewhat farther from the stalk than usual, and on that side too which faced another hillock in a quarter from whence our strongest winds most commonly blow. In this ear alone, I found about twenty grains which were full grown and ripe. I attributed

this to the farina brought by the wind from a distant plant. In those ears from which I plucked off some of the styles, I found just so many ripe grains as I had left styles untouched. In those covered with muslin, not one ripe grain was to be seen. The empty or barren eggs were nothing but mere dry husks.

"From these experiments, which I made with the utmost care and circumspection, as well as from those made by a great many other persons, it is very plain, that this farina emitted from the summits of the styles, is the true male seed, and absolutely necessary to render the uterus and grain fertile, a truth which however certain, yet was not known till the present age. The discoverer of this grand secret of nature ought ever to be remembered with due applause. Sir Thomas Millington, sometime Savilian professor, seems first to have taken notice of it, before or about the year 1676 [simply a conjecture without experimental proof] according to the account which Dr. Grew gave in a lecture read before the Royal Society the 9th of November the same year (see Grew's Works p. 161, 171). Malpighi nowhere that I know of, mentions its use. And Grew himself, though he allows it necessary for fecundation, yet did not suspect that it entered the uterus: but S. Morland about twenty years after, asserted that it entered the uterus through the canal of the style (see Phil. Trans. No. 287). I once saw a small grain in the middle of this canal; nor is it to be doubted, but that stricter inquiries will discover more of them passing the same way."

In another paragraph, Logan seems to presage the discovery of the fact that nature abhors continuous self-fertilization by providing many adaptive floral arrangements. He says: "Not only in this plant, in nut bearing trees, reeds, in all the tribe of gourds, as pompions, melons, cucumbers, etc., in which the male and female parts of generation are separately placed, but also in most of those flowers which from both parts being placed within the same flower-cup, are by some called hermaphrodites, the apices are so situated that after the farina is perfected, they can seldom, if ever, touch the summit of the style or os uteri. But in these, as well as in such where the organs are separately placed, the farina must of necessity, after it is thrown off from the apices, float in the circumambient air and be subject to the hazard of not reaching the os uteri, and performing its office there," etc.

Another observation of his is quite modern in its view: "There is likewise farther to be observed in the maize, that on the same day when the apices burst and hang loosely waving in the air, the skein or bundle of styles appear from under the husk or sheath that covers the ear, and are in like manner exposed. This circumstance should put us upon observing what happens in this respect to other plants."

It is certainly to be regretted that Governor Logan did not observe what happens in other plants, but gave his time and attention to state affairs, for much that Sprengel afterwards made known might have been unraveled by him. His experiments might pass for those of the present age, but unfortunately he did not confine himself to recording facts pure and simple, but in the latter part of his paper wandered off into disquisitions on the nature philosophy of his day. The following explanation of Logan's to account for the sexual process smacks of medieval scholasticism.

He states boldly, that his observations are in support of the doctrine of sexes in plants, and that "there is room to apprehend that this [Logan's] hypothesis concerning generation will be readily adopted by posterity." "The farina is committed to the air, that it may receive out of the air, the little seed or plant, pre-existent and completely formed, tho' in stamina inconceivably minute and invisible; and thus becomes pregnant thereby." "It is drawn by an inherent attractive force first into the style, and through that it slides by proper canals to the ova, and from this farina, nourished by the juices of the plant for the purposes above described, the bulk of the seed is formed. Lastly the little plant hid in the seed and clothed with a terrestrial matter, which it borrows from the farina, exerts itself, and, increasing by proper nutriment, which it draws from the earth, at length springs up."

One is reminded of the theory of evolution of Claude Perrault and of his "aura coelestis" of the opinions of Wollaston and Varro. Logan, although he had worked at the matter experimentally was unable altogether to throw off the shackles of scholasticism. So much is a man influenced by the age and time in which he lives. Nevertheless, Governor Logan deserves more than a passing mention in any future discussion of the sexual theory of plants.

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A preliminary synopsis of the North American species of Amaranthus.

EDWIN B. ULINE AND WILLIAM L. BRAY.

(*Concluded from p. 272.*)

§ 2. *Sepals 5, oblong with mucronate tip, or acute, pungent pointed, not conspicuously nerved, mostly unequal (the outer one long and spiny pointed), thin or somewhat thickened at the base, not urceolate: utricle thin, scarious and little wrinkled or retracted after dehiscence: leaves mostly large and long petioled: flowers in naked terminal or axillary mostly panicled spikes* (EUAMARANTHUS).

The species of this section are with difficulty distinguished.

* *Stamens only 3.*

Forms related to those of § 1, but with nearer relationship to typical Euamaranthus.

12. A. POWELLII Watson. Proc. Amer. Acad. **10:** 347. 1875.

The three species of Watson, viz: *A. Powellii*, *A. Wrightii*, Proc. Amer. Acad. **12:** 275. 1877 and *A. obovatus*, l. c., together with certain Arizona and Oregon specimens constitute the species as re-defined. The group of forms thus united stand midway between the AMBLOGYNE and EUAMARANTHUS sections. On plant habit and inflorescence it would be impossible to separate these satisfactorily from the remaining Euamaranthus species, but in all the plants of this species that we were able to examine, no exception occurs to the three stamen character, while out of ten plants each of *A. retroflexus* and *A. hybridus* carefully examined, scarcely a reliable exception to the five stamen character was found.

* * *Stamens 5.*

Includes a maze of indistinguishable forms comprising some of the coarsest and rankest weeds. Of the several species previously enumerated, but two are retained.

13. A. RETROFLEXUS L. Sp. Pl. Ed. II. 1407. 1762.

Spreading everywhere throughout the United States as a coarse rank week, sometimes growing eight to ten feet high. Apparently indigenous southwestward where it may be satisfactorily distinguished from *A. hybridus* by its strict spikes, oblong sepals, green color and pubescence.

14. A. HYBRIDUS L. Sp. Pl. 990. 1753.

A. hypochondriacus L. Sp. Pl. 991. 1753.

A. Chlorostachys Willd. Hist. Amarant. 34. *pl. 10. f. 19.* 1790.

A. Chlorostachys var. *hybridus* Wats. Gray's Man. Ed. 6. 428. 1889.

This species is scarcely less widespread than the preceding, also indigenous southwestward, both species having rapidly spread northward from tropical America. Typical specimens reported from Mexico are distinguished from *A. retroflexus* by the longer drooping spikes, acute unequal sepals and mostly brown scarcely pubescent stem. In their spreading northeastward these two species overlap so much in characters that frequently no distinction can be made. The name *hybridus* is given preference by reason of its sequence in the Linnæan order of presentation.

Var. PANICULATUS Uline and Bray, Mem. Torr. Bot. Club, **5**: 145. 1894.

Not sufficiently distinct from the species, but provisionally embraces those forms having reddish color and lanceolate leaves, and particularly those with very long, slender, flexuous, paniculate spikes and commonly shorter bracts.

15. A. CAUDATUS L. Spec. Pl. 990. 1753.

A. leucospermus Wats. Proc. Amer. Acad. **10:** 347. 1875.

Resembling *A. hybridus*, but easily recognized by the white or yellowish seed with rimmed margin (marking the albumen line). Originally from the American tropics but spreading northward in Arizona where the Indians cultivate it for the seed.

* * * *Stamens irregularly 3 to 5: bracts very long and acuminate.*

16. **A. bracteosa,** n. sp.

Plant erect or ascending, glaucous: leaves distant, fleshy, long-petioled, spatulate-obtuse: glomerules interrupted, axillary and terminal: bracts foliaceous, awl-shaped, 6 to 10^{mm} long (thrice the length of the calyx).—New Mexico (*A. Fendler* 735 in 1847.)

This specimen is in the Gray Herbarium and is labelled *A. retroflexus*, though it is radically distinct from that species as it is from all other Euamaranthi in its thick glaucous spatulate leaves and the remarkably long leafy bracts. Another specimen in the National Herbarium was raised from Arizona seed by Dr. Vasey in 1876. Its locality in Arizona is not known.

§ 3. *Sepals 5: utricle thin, bursting or imperfectly circumscissile: a pair of stipular spines in the axils of the large leaves.*

17. A. SPINOSUS L. Sp. Pl. 991. 1753.

Known as the only thorny amaranth. A slovenly weed, spreading from South America northward through Mexico and the West Indies, throughout southern and southeastern United States north to Kansas and New England.

§ 4. *Sepals various: flowers in very small axillary spikes or clusters: stem low or prostrate with smaller leaves than in the preceding sections: stamens 3.*

* *Sepals of both kinds of flowers 4 or 5: plant prostrate: utricle circumscissile: seeds large* (1.3^{mm}).

18. A. BLITOIDES Wats. Proc. Amer. Acad. **12:** 273. 1877.

Indigenous westward; first described from Nevada specimens. In recent years it has spread eastward over all the temperate portion of the United States to the Atlantic coast, occurring most abundantly in the vicinity of the larger thoroughfares. *A. blitoides* has heretofore been classified with the Pyxidium group, the error being due to a mistaken conception of the number of fruiting sepals. Watson assigns three sepals to it, though it is difficult to see how he could have committed the error, for the very types upon which he founded the species clearly contain four or five sepals in addition to the subtending bract.

Var. **densifolius,** n. var.

Leaves exceedingly crowded, small, oblanceolate (1 to 2^{cm} long).—Arizona, Hackberry (*Rusby* 804); Colorado (*Greene* 614).

Var. **Reverchoni,** n. var.

Stem and branches very slender: leaves narrow, reduced, not crowded: calyptra of utricle brownish red.—Collected near Dallas, Tex., in 1881 (*Reverchon*, 824).

The character of red coloration in the utricles is not exclusive, but was also seen in specimens of *A. blitoides* from Providence, R. I., and Scott's Bluff co., Neb.

* * *Sepals four or five, spatulate, united at base: peduncles and pedicels (apparently abnormally) thickened* (SCLEROPUS.)

+ *Utricle indehiscent, thick, coriaceous: style branches 2, lyrate in fruit.*

19. A. CRASSIPES Schlecht. Linnæa, **6:** 757. 1831.

Geographical range the same as *A. polygonoides* with which it has been included (Hemsley Biol. Cent. Am. 3: 14) on the supposition that the incrassate character of the peduncles is pathological. This

plant would not fall with *A. polygonoides* even if this were true, because of more widely differing characters. Mr. Holzinger's investigations (Bot. Gaz. **17**: 254. 1892) seem to show that the incrassations are not pathogenic, but normal. In any case the phenomenon is constant in geographical limits and suffices in itself for a reasonably stable diagnostic character.

+ + *Utricle circumscissile, smooth: style branches* 3.

20. **A. scleropoides,** n. sp.

Stem whitish, slender, erect (3^{dm} high) with few erect branches: leaves small (1 to 1.5^{cm}), oblanceolate: peduncles and pedicels indurated: sepals five, unequal, spatulate, one-nerved, united at base: utricle smooth, circumscissile, equalling the calyx: stigmas two or three, divaricate at maturity: seed obovate, 0.6^{mm} in diameter.—Near El Paso, Texas (*Wright* 582 *in part*).

Quite distinct from *A. crassipes* in habit, character of seed, utricle and stigmas. It may be regarded as intermediate between *A. crassipes* and the Pyxidium section, approaching the latter by reason of its dehiscent utricle and three stigmas. From *A. græcizans*, its nearest relative, it is distinguished by its obovate seed, shorter stigmas, smooth utricle, short bracts and indurated peduncles.

* * * *Sepals thin, inconspicuous,* 3 *or fewer.*

\+ *Sepals* 3.

++ *Bracts conspicuous, long, pungent: seed small* (0.6^{mm} *wide*).

= *Plant erect.*

21. A. GRÆCIZANS L.[1] Sp. Pl. 990. 1753.

A. albus L. Syst. Ed. X. 1268.

A. albus Willd. Hist. Amarant. *pl. 4. fig. 7.*

[1]Of the Pyxidium group as defined by Moquin-Tandon, the following have been referred to North America: *A. blitoides* Wats., *A. albus* L., *A. græcizans* L. (*A. Blitum* var. *græcizans* Moq.), and *A. Blitum* L. *A. blitoides* is easily told by its four or five sepals, thick at base, and by the prostrate habit. But great confusion prevails in the remaining forms. *A. albus* was said by Linnæus (S. X. 1268) to have come from Pennsylvania while A. *græcizans* (Sp. I. 990) was ascribed to Virginia. But there is only one set of forms in our eastern states that can approximate any correspondence to the descriptions, namely, that one long known as *A. albus* L. Linnæus (Mant. II.) declared them to be too nearly related, while Willdenow unquestionably figures our plant under the name of *græcizans* (Hist. Amarant. *pl. 4. fig. 7*). Moreover, specimen 1931 *Hartweg* from California, which Moquin calls *A. Blitum* var. *græcizans* (*A. græcizans* L.) is *A. albus* L. and was so named on the sheet in Sereno Watson's handwriting. *A. græcizans* and *A. albus*, then, are identical, and the older name is retained. This arrangement also eliminates *A. Blitum* from the North American flora,

One of the so-called "tumble weeds," found everywhere from Arctic North America to Mexico. It is very variable in habit, assuming the spherical tumble weed shape in the upper Mississippi valley and on the western plains. Known from its habit and particularly from the numerous long pungent bracts. Certain upright forms with larger leaves and tardily dehiscent utricle resemble the erect *A. Californicus*, but the presence of long bracts points to *A. græcizans*.

Var. **pubescens,** n. var.

Diffuse, spreading from a common root-stock, covered with dense viscid pubescence, which at length causes the plant to be covered with sand and dust: leaves very much crisped: bracts broader and shorter, not so sharply pungent: sepals thicker and longer than in the species.—New Mexico and Arizona.

Specimens examined: New Mexico, Silver City (*Greene* 185 in 1880), Empire City (*Torrey* 457 in 1865), Camp Bache (*Bigelow* in 1852), place unknown, (*Fendler* 731 in 1847); Arizona, Flagstaff (*Jones* 3978 in 1884), San Francisco Mts. (*Knowlton* 198 in 1879).

= = *Plant prostrate.*

22. A. CARNEUS Greene. Pitt. **2**: 105. 1890.

Prostrate, branches somewhat radiate, slender, pinkish, the glomerules and lower face of the leaves purple: plant floriferous throughout: leaves setose-tipped, 1.5 to 2.5^{mm} long: bracts acuminate, setose-tipped (shorter than those of A. græcizans): utricle smooth, seed 0.6^{mm} wide.—Montana, Idaho and Oregon.

This species is too near *A. græcizans* in leaf, bract, floral, and seed characters; but in its depressed habit and an occasional reduction of sepals either in number or size, it seems to be working out certain characters of *A. albomarginatus*.

++ ++ *Bracts not conspicuous: seeds larger.*

23. A. BLITUM L. Sp. Pl. 990. 1753.

See footnote under *A. græcizans*, p. 316.

for the plants referred to in Man. 6th. ed. from New York city and Boston under that name prove to be either *A. blitoides* or *A. lividus*. It also serves to distinguish *A. græcizans* L. and *A. sylvestris* Desf. which are reduced to one under the name *græcizans* in the Kew Index. The latter stands as Moquin's idea of typical *Blitum* (*A. Blitum* α *sylvestris* Prodr. **13**^{2}: 263), which he says was recognized by Planchon as identical with Linnæus' type in herb. Adding to this Willdenow's suggestion that perhaps *A. græcizans* was not eastern at all, *A. Blitum* must be taken as the abundant Continental and oriental form, a view which is repeatedly substantiated by the labels on the old specimens in the Bernhardi herbarium.

++ *Sepals fewer than* 3. (MENGEA).

24. A. CALIFORNICUS Wats. Bot. Calif. **2**: 42, 1880.

Mengea Californica Moq. DC. Prodr. **13**²: 270. 1849.

Diffuse ascending or erect: leaves spatulate or ovate varying from 0.5 to 3.5^{cm} long on the same plant, only the uppermost white-margined. Flowers not differing essentially from the following.—California, from San Diego to Mendocino county, and western Nevada.

25. **A. albomarginatus,** n. sp.

A very dense-leaved prostrate plant forming a dense mat on the ground. Stem white, leaves elliptical, uniformly very small (the smallest known in the genus, averaging only about 3 to 4^{mm} in length), all conspicuously white-margined: flowers crowded amongst the dense foliage, sepals reduced to 2 or 3 minute scales, mostly appearing only one-sepaled.—Monterey co., California (*Palmer* 456 in 1876). Distributed as *A. Californicus.*

§ 5. *Sepals two to five, narrowly oblong or spatulate, widely separated, mostly longer than the indehiscent utricle: bracts inconspicuous.*

Six species of this section are found in the United States. It is interesting to note that all of these occupy about the same relation to our flora in being adventive, or but recently introduced from other countries. Thus, excepting that *A. crispus* is found at Albany, N. Y., *A. emarginatus* Salzm. only at New Orleans, and *A. deflexus* "in gardens about San Francisco Bay" (*Greene*), all are confined to the coast belt between Boston and Key West. Their presence may be attributed to introduction through shipping, except in the case of *A. viridis* L. which is especially interesting. We have examined plants of this species, which show no notable variation, from Paraguay, Brazil, British Guiana, West Indies, Mexico, New Orleans, southern Florida, North Carolina and New Jersey. (In the last two places on ballast ground.) This indicates a path of progress northward from its indigenous region "where it is the common pig-weed" (Morong, on labels of specimens from Paraguay).

* *Stem erect, succulent, mostly deep red or purple: leaves large.*

\+ *Utricle smooth, scarious.*

26. A. LIVIDUS Linn. Sp. Pl. 990. 1753.

Further distinguished from the next by its larger, more emarginate leaves, fleshier stem, inflorescence more glomerulate, with a short rather thick terminal spike.—Found about Boston and New York city.

+ + Utricle rugose, coriaceous.

27. A. VIRIDIS L.[2] Sp. Pl. Ed. II. 1405. 1762.

Leaves rather smaller and more acute than in the preceding: inflorescence in slender flexuous spikes, the terminal longest, with several shorter ones crowded near its base.

Stem weak, flexuous, prostrate: leaves small.

+ Utricle smooth, leaves deeply emarginate.

28. A. EMARGINATUS Salzm. ex Moq. l. c. 274.

Euxolus viridis var. *polygonoides* Moq. DC. Prodr. **13**[2]: 274. 1849.
A. viridis. Index Kewensis **1**: 100. 1893.

Stem long and very weak, prostrate: leaves small, 1 to 2^{cm} long (not including petiole), 0.5 to 1.5^{cm} wide, rhombic-ovate, deeply emarginate, on long slender petioles which are about twice the length of the blade: inflorescence in small axillary clusters and very slender terminal spikes: bracts and sepals inconspicuous: utricle thin and smooth.—Probably South America.

Specimens examined: LOUISIANA, "Streets of New Orleans near river port, perhaps adventive" (*Langlois* no. 58. 1884). TEXAS, Matagorda Bay (*J. W. Robbins*, 1868).

This species stands near to *A. lividus* and *A. viridis*, having the smooth scarious utricle of the one and the inflorescence of the other. But the very slender whitish stem and small leaves make it rather more distinct from those than they are from each other.

+ + Utricle rugose: sepals 5: leaves crisped.

29. A. CRISPUS Braun. Gray's Manual 6th Ed. 428.

Native habitat unknown. For many years reported from Albany, N. Y.; also from "streets and uptown waste places" New York city and Brooklyn. We have seen specimens from the botanical gardens of Berlin and Harvard University.

+ + + Utricle fleshy, prominently 3 to 5-nerved, much exceeding the 2 or 3 sepals.

30. A. DEFLEXUS L. Mant. **2**: 295. 1767.

Easily distinguished from *A. crispus* by the above characters and the larger oblong seed, and short thick terminal spikes.

Native habitat said to be southern Europe. It is reported from

[2] The names *lividus* and *viridis* have both been used to designate each of these two forms; some authors calling the smooth utricled form *A. viridis* and rugose one *A. lividus*, while others have done just the reverse. We have here decided to use the names as indicated on specimens compared by Dr. N. L. Britton at Kew.

Valparaiso, Chile, and recently from the San Francisco Bay region. All the specimens seen from the United States were from ballast soil. Now well established about New York city. (*Addison Brown*, 1880.)

* * * *Stem short, fleshy.*

31. A. PUMILUS Raf. Med. Repos. **5**: 360. 1808.

Found on the Atlantic coast from Rhode Island to North Carolina. Leaves fleshy rhombic-ovate to ovate, sometimes almost orbicular.

This species has the largest seed of any member of the genus known to us, and also departs farther from the generic type than any other species.

32. **A. acutilobus** (A. Br. & Bouché), nom. nov.

Euxolus emarginatus A. Br. & Bouché Ind. Sem. Hort. Berol. 1851, not Salzm. ex Moq.

A. viridis Index Kewensis **1**: 937, in part.

Habit of *A. emarginatus:* the leaves narrower and more retuse, almost obcordate with acute lobes: inflorescence axillary, crowded toward the tips of the branches in a loose leafy spike: bracts very conspicuous, setose, at least twice the length of the utricle, in this respect differing radically from all of the *Euxolus* section.

Two of the sheets examined bear the signature of A. Braun, dated 1851 and 1857, at which times were issues of "Indices Seminum" of the Berlin Bot. Garden by A. Braun and Bouché. We saw one specimen from the Bot. Gard. Harvard University 187– and also one from Mo. Bot. Gard. Herb. with place of cultivation not mentioned. All the others were raised from Mexican seed.

Herbarium Lake Forest University, Lake Forest, Ill.

Crystals of ice on plants.

J. CHRISTIAN BAY.

That ice crystals are formed on the surface of plants under certain conditions of weather and surroundings, as has been noticed lately by Profs. L. F. Ward and D. T. MacDougal, is by no means little noticed. In the winter and spring of 1892 and 1893, these crystals were not unfrequent in Tower Grove Park and the adjacent fields in St. Louis, and I observed this phenomenon also in Europe, in the Botanic Garden, Copenhagen, as far as I remember, in the winter of 1887–88.

Supposing that the phenomenon has been sufficiently outlined by the two first named observers[1], I add the following references to those named by MacDougal.[2]

James D. Dana mentions[3] that he has found, on cold mornings in spring and autumn, thread-like ice-crystals appended vertically to the stems of trees. Papers concerning the same subject are:

R. CASPARY, Auffallende Eisbildungen auf Pflanzen. Botan. Zeitung **12:** 665. 1854. H. HOFFMANN, Pflanzenklimatologie 329. 1857. HUGO VON MOHL, Botan. Zeitung **18:** 15, 16. 1860. J. SACHS, Krystallbildungen bei dem Gefrieren. Berichte d. kgl. Sächs. Akad. d. Wiss. zu Leipzig. Math.-phys. Cl.—:1. 1860. C. NÆGELI, Ueber die Wirkungen des Frostes auf die Pflanzenzellen. Sitzungsber. d. Münchener-Acad. d. Wiss. Math.-phys. Cl., 9 Februar, 1861.

The communication of Sachs is, of course, classical. It should be remembered that H. de Vries and H. Müller-Thurgau have also been working with the influence of cold upon plant cells; likewise Goeppert.

a. Plants on which ice-crystals have been observed.

Conyza bifrons L. (Pluchea bifrons DC.) [S. Elliott, 1824.]
Carduus sp. [Herschel, 1833.]
Heliotropium sp. [Herschel, 1833.]; H. peruvianum (Bouché and Caspary, 1854.)

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[1] See BOT. GAZ. **18:** 183. 1893.—Science—: 351. 29 D 1893.
[2] Cf. also Quarterly Bull., Univ. of Minn. **2:** 30–31.
[3] Manual of Mineralogy, 46. Ed. 2, New Haven and Philad., 1849.

Cunila Mariana [Darlington, 1837; John Le Conte, 1850; L. F. Ward, 1893; MacDougal, 1893; Atkinson, 1885–6. (see Bot. Gaz. **19:** 40–42. 1894.)]

Pulchea camphorata DC. [John Le Conte, 1850.]

Helianthemum Canadense [Eaton and Bigelow; publ. 1837 by Darlington.]

Lantana aculeata, Tagetes Bonariensis, Perilla arguta, Alonsoa incisifolia, Cuphea cordata, C. tubiflora, C. platycentra, Manulea oppositifolia, Calceolaria perfoliata [Bouché and Caspary, 1854.]

Viburnum Tinus [Hoffmann, 1857.] (?) Vernonia sp. [Atkinson, 1885–6.]

Aucuba sp. [Hoffmann, 1857].

Gymnocladus sp., Ailanthus sp., Juglans sp., Asimina triloba, Paulownia; leaves. [von Mohl, 1860.]

Rhamnus sp., Amygdalus communis [Bay and Jensen, in scheda, 1887–88.]

The splitting of wood and the appearance of ice-crystals in the fissures are well known phenomena to tree-planters. In twenty-seven plants, the crystals have been hitherto observed; only those who do not possess sufficient knowledge of the literature will believe that a re-discovery has been made.

The occurrence of similar ice-crystals on the ground is well known in Germany where the crystals are called "Kammeis" (comb-ice); it has been investigated by J. Le Conte, von Mohl, Sachs, Hoffmann, and Caspary.

The many observations on sections of plants, made by Sachs, Nägeli, H. de Vries (Botan. Zeitung **37:** 649. 1879), and by H. Müller-Thurgau (Landw. Jahrb. **9:**) should be mentioned in this connection, only because they afford an opportunity of forming an opinion of the causes of these phenomena.[4]

b. Forms of the crystals.

1. Single ice-columns on the surface [Elliott, Hoffmann, Sachs, Bouché and Caspary]; id. on the surface of root-sections of *Beta* [Sachs; see also Bonnet, Usage des feuilles, p. LXXXII. 1754.]

2. Ice-threads united in sheet crystals [Herschel, Dana, Le Conte, Bouché and Caspary, Ward, MacDougal, Bay and Jensen].

3. Crystals of ice united and forming a layer on the surface; (*a*) under the bark of dead trunks, [Herschel], (*b*) of living trunks [Caspary], (*c*) on the fresh surface of the leaf-pulvinus of falling leaves [von Mohl], (*d*) on the surface of sections [Sachs, Nägeli, de Vries, Müller-Thurgau.]

In consequence of this, MacDougal's results one and two (l. c., p. 351) are premature, and cannot be maintained, since they do not represent all of the observations hitherto made.

[4] On the temperature of perennial plants in winter see Russell, Bot. Gaz. **14:** 216–222. 1889, and J. Le Conte, Am. Jour. Sci. II. **13:** 84–92, 195–206. 1852.

c. Formation of crystals.

1. The form and fabric of the crystals indicate that the latter grow, and that they are somatropic. The end of the crystals were first formed, and as the column grew, the primary ice-layers were pushed out into the places where they are afterwards found.

2. The central parts of the water-supply layers do not freeze.

3. The formation of the crystals does not result from the organic nature of the substratum; it depends entirely upon molecular forces.

That capillary forces are active in carrying water from the ground up to where the crystals are formed may be seen *a priori*; but the capillary forces *alone* cannot explain the phenomena here mentioned; the question is much more complicated. The contraction of the cells is one important factor, and the permeability of the membrane is another.

Von Mohl's explanation of the appearance of ice-crystals is "that the cold, before it pervades the branches, first causes a contraction in the outer layers, by this contraction the fluids are driven out into the already formed fissure, and there it freezes." That contraction of the layers in the lower parts of the stem of Cerasus does take place, I observed in the following way. The lower parts of the stem, measuring 10^{cm} in length, and about 4^{cm} in diameter was cut off from the rest of the young tree, and kept for three days at a temperature of 18° C. On the fourth day this piece, which had been hitherto kept in wet rags, was dried and placed outside the window where the temperature measured $-5°$ C. After a while big drops of fluid were observed on the cut surface of both ends, covering the entire surface; this fluid rapidly froze, and formed, in five hours, a layer of ice in the place where it had been forced out. A similar experiment was made by von Mohl on Rhamnus. (Cf. Sachs, l. c., 14). The ice-column at the ends of the stem were of a slight white color; they contained a great number of minute air-bubbles.

While Atkinson thinks "that there is a degree of root activity which furnishes the necessary water," and that "a specific variation in the root activity of different plants as related to different temperatures" is a factor in the development of the crystals, Mac Dougal is of the opinion that capillary forces are the only active agents. In regard to the first opin-

ion, it is no doubt remembered that Sachs viewed the matter thus: "Jede Kraft, welche sehr langsam und continuirlich ein Austreten des Wassers im Sinne der Imbibition bewirkt, kann die Krystallbildung befördern, solche Kräfte sind die Contraction des Gewebes, der von den Wurzeln aus stattfindende Saftdruck." The older experiments of Sachs, as well as the latest investigations of Strasburger and especially of Schwendener[5] show that we know very little of the means by which water ascends to the middle and the higher parts of trees. Yet sheet-crystals are found at a considerable distance from the bases of the stems. As to the specific variations surmised by Atkinson, no record of experiments concerning them can be found in my lists of literature.

Capillary forces alone would hardly be able to supply the crystals, especially those on branches of trees, etc.; the old experiments by Montgolfier and Jamin, and the numerous later experiments with Jamin's chain prove this. It is well known that in capillary spaces filled with air and water, the latter does not move to any great extent.

For these reasons, and from the above mentioned freezing experiment, it becomes evident that the exudation of water from cut surfaces is in the first place caused by the contraction of the cells and tissues; we further know that cold produces a power of filtration in the membranes greater than under normal conditions of temperature. In cold, only a very slight pressure will be necessary to make the fluid appear at the ends of the wood. As far back as 1859, this was proved by Sachs (l. c., 39).

We have seen that the sheet-crystals are not only formed in the basal part of the stem, but that they are also found on branches of trees. Assuming root-pressure as one of the water-supplying agencies, we consider it quite remarkable that this should not be active in some cases; in other cases, however, no root-pressure can, for obvious reasons, occur.

Schwendener's investigations point towards "Triebkräfte besonderer Art" in the stem, and, as the specific nature of these forces is unknown, it is most safe to say that any agency which is able to force water upwards through the stem can supply the ice-crystals with water.

[5] Sitzungsberichte der Akademie der Wissenschaften zu Berlin —: 561, 1886, and ibid, October 26, 1893.— I may add that it is four years since I saw Le Conte's paper; at present I have access only to the review in the "Annals of Scientific Discovery," ed. by D. A. Wells, Boston 1851, p. 157–160.

d. Conditions of formation of crystals.

From what has been said it appears that the conditions for the formation of the ice-crystals are:

1. The temperature must be above zero in the soil surrounding the roots of the plant [Le Conte and Sachs].
2. The temperature of the central parts of the water-conducting tissues must be above zero.
3. The soil must be sufficiently charged with water.

Summary.

The cold causes a contraction of the tissues all over the plant, and consequently the turgescence is very much diminished, as well as the permeability of the cell-walls to water. As the contents of the peripheral ends of the medullary rays freeze, expand, and are pressed forward, the stem splits in the place where it affords the least resistance, and the ice forms a layer covering the whole surface of the wound. The pressure from inside supplies water, the latter being drawn up by capillary forces.

Assuming that the freezing of the water in the ends of the medullary rays was, alone, the cause of the splitting of the stem, this explanation would be insufficient to explain the whole process, for, in many plants, the freezing does not cause the splitting and subsequent exudation from the cells.

It has been proved (Sachs, Müller-Thurgau, De Vries) that the coefficient of contraction is different in the different tissues, and it may be assumed that different plants (even different individuals of the same species or different parts of the same plant) have a different coefficient. MacDougal supposes that plants with large and numerous vessels and thin-walled cells in the medullary rays are especially adapted to form sheet-crystals. It is quite sure that such plants have a larger coefficient of contraction than other plants.

Capitol, Des Moines, Iowa.

[Since the above article was written, I have found a quite interesting note entitled "Frost, and the Cunila Mariana L., or dittany," by J. Stauffer, Mount Joy, Penn'a, in The Horticulturist and Journal of Rural Art, **7**: 73–74. New York, 1857. On December 6, 1856, Mr. S. was passing near the Willistown Baptist Meeting House, in Chester co., Pa. Here, he found the ice crystals: "What, however, amply recompensed me for the attention bestowed, was the discovery

that this plant is peculiar, and is truly a *frost plant* far exceeding the *Helianthemum Canadense*, or frost weed, as it is popularly called, from the fact that, late in autumn, crystals of ice shoot from the cracked bark at the root. Our *Cunila* has attached to the stem a shell-work of ice, of a pearly whiteness, beautifully striated, sometimes, like a series of shells one in another—at others curved round on either side of them like an open, polished, bi-valve; then, in others, again, curled over in every variety of form, like the petals of a tulip. No other herb or grass had any such frost-work around them; while at least fifty specimens of the *Cunila* were so ornamented. The root manifested a vigorous young bud underground."—BAY.]

Noteworthy anatomical and physiological researches.

Nourishment of the embryo and importance of the endosperm in viviparous mangrove plants.

The remarkable phenomena attending the germination of viviparous plants in the Rhizophoreæ and other mangrove plants have been noticed by a number of investigators. In the present paper[1] Haberlandt makes a noteworthy contribution to the knowledge of the subject.

Treub[2] was the first to call attention to the peculiar behavior of the endosperm in the Verbenaceous *Avicennia officinalis* which, with its included embryo, grows out of the micropyle into the cavity of the fruit while the latter is still attached to the tree. Later the placenta pushes out into the fruit in all directions, the endosperm serving as a haustorium to secure the necessary food for the embryo.

Warming[3] observed a similar outgrowth of the endosperm in *Rhizophora Mangle*. He describes it as a large celled clear tissue apparently entirely wanting in food material and extending above the ovule as a micropylar arillus, whose office seemed to be to conduct nourishment from the mother plant to the embryo. However he brought no certain proof to support this view. In this plant, according to Warming, the entire surface of the upper part of the cotyledon is thickly covered with glandular hairs, below which lie scattered secretory or haustorial cells which he calls true sessile glandular hairs.

Goebel[4] described vivipary in certain mangrove plants and also touched upon the haustorial nature of their endosperm. He states that the embryo in the rhizophorous *Bruguiera gymnorhiza* takes part of its nourishment from the cotyledons but that a large portion of the starch of the hypocotyl arises from its own assimilative activity, since a considerable amount of chlorophyll is found in its external tissues. Goebel also

[1] G. Haberlandt, Ueber die Ernährung der Keimlinge und die Bedeutung des Endosperms bei viviparen Mangrovepflanzen. Annales d. Jardin botanique d. Buitenzorg, **12:** 91–114. 1894. *pl. 10–12.* Leide: E. J. Brill.

[2] Notes sur l'embryon, le sac embryonnaire et l'ovule. Ann. d. Jardin bot d. Buitenzorg. **3:** 79 ff.

[3] Tropische Fragmente, II. Engler's Jahrb. **4:** 517 ff. 1883.

[4] Pflanzenbiologische Schilderungen, **1:** 113 ff. 1889.

maintains that the endosperm in this plant is consumed by the cotyledons. In the case of *Rhizophora conjugata* the same author considers that the endosperm, by means of the marked lateral growth of its upper portion, possesses the mechanical function of opening widely the micropyle, and thus serves to lead the way for the developing embryo or "cotyledonar bodies" whose upper surface is composed of a richly absorbing plasma tissue.

A. F. W. Schimper[5] has also furnished a valuable contribution to the literature of vivipary in the mangroves, especially in the myrsinaceous *Ægiceras majus* and in *Bruguiera caryophylloides*. In the latter the cells of the testa, rich in plasma, are provided with large nuclei and secrete a ferment. True assimilative activity in this case is greatly hindered by the want of stomata and by the thick cuticle. In *Rhizophora mucronata* the cone-shaped endosperm emerges from the micropyle and is soon perforated by the rapidly growing hypocotyl. The cotyledon is divided into three parts; the upper conical end represents a haustorium and its surface possesses a glandular structure similar to that of the cotyledons of Bruguiera. The central portion is expanded and prevents the heavy embryo from slipping down, while the petiolar basal part, which projects from the pericarp like a collar or crown, serves as a protective sheath for the plumule.

Finally, G. Karsten[6] has made very serviceable studies of the germination of the mangroves.

Haberlandt's observations have been confined principally to three species: *Bruguiera eriopetala*, *Rhizophora mucronata* and *Ægiceras majus*. In the young fruit of the first species can be seen solitary semi-lenticular endosperm cells, rich in plasma, which lie between the cotyledons and seed covering. These are the remains of the primary endosperm. Similar cells are also found in the endospermous slime which fills up the canal resulting from the juxtaposition of the cotyledons. Sometimes a roundish cluster of cells separated by their septa occurs. From the widely open micropyle projects a true endosperm tissue in the form of a collar or arillus, 2–4^{mm} in width. This, however, is not reflexed as is usually the case in this genus and does not surround the embryo, but is intercalated between the calyx and the uppermost part of

[5] Die indomalayische Strandflora, 42 ff. Jena 1891.

[6] Ueber die Mangrove-Vegetation im Malayischen Archipel. Bibliotheca Botanica 22:—1891.

the hypocotyl. To the function of this organ we shall recur soon.

The importance of the above-mentioned semi-lenticular cells has been entirely overlooked by previous writers. According to Haberlandt they serve as starting points for the development of a many layered secondary endosperm which forms the haustoria already mentioned. This secondary endosperm sends between the loose parenchyma cells of the seed coat haustoria-like processes of one to many cells. These haustoria are frequently lobed and possess papillose ends. Their walls are of thick cellulose excepting those of the terminal cells which are thin.

The author sketches the development of this peculiar structure, which finally forms a flattish disk whose cells are easily distinguished from the surrounding parenchymatous tissue by their thickened walls and abundant content of protoplasm. The primary endosperm at this time has become reduced to a few cells. If now the sides of the cotyledons lying next to the testa are examined, their cells will be seen to be arranged radially, with the outer layer colorless and characterized by an abundance of plasma and large nuclei. In this stage of development the cotyledons act only as absorptive organs.

Haberlandt removed the cotyledonary bodies, which at this period are about as large as peas, carefully washed them and gave them a coating of wheat starch. Microscopic examination after twenty-four hours showed that the grains of starch were strongly corroded, thereby confirming the previous supposition of Schimper that the cotyledonary tissue secretes a diastatic ferment. The same corrosion was exhibited by the layer of secondary endosperm. Upon making cross sections through the integument and the endosperm the interesting fact was brought out that in many places solitary endosperm cells send in tube-like processes between the palisade tissue of the cotyledons, often to a depth of two or three layers of cells. These evidently serve to form a point of union between the endosperm and the embryo.

The author next considers the function of the so-called "endosperm collar" which lies between the calyx tube and the upper part of the hypocotyl. At this place the endosperm is thickened and has an uneven outer surface with tooth-like projections. These teeth or lobes extend in length

and send strong haustoria into the calyx tube. The parenchyma cells of the calyx tube lying between these haustoria are marked by their large size and thin walls. Here, to all appearances, the developing embryo secures the greater part of its nourishment. In addition to obtaining food the endosperm collar has a purely mechanical function. The fruit of *Bruguiera eriopetala* falls off when the hypocotyl has reached a length of 8 or 9^{cm}. The young seedling at this stage possesses neither sufficient strength nor firmness, nor does it fall far enough to fix it vertically in the slimy soil. This position is secured by means of the firm, pointed calyx lobes which serve as an anchor. At the same time the strongly turgescent endosperm collar takes up water and increases considerably in thickness, thus acting as a wedge to separate the calyx from the hypocotyl and reminding one of the lodicules in grasses which, according to Hackel,[7] by their rapid swelling push away the glumes and thus effect the opening of the flower.

Haberlandt undertook a quantitative analysis of the chlorophyll in the hypocotyl of *Bruguiera eriopetala*, to ascertain whether there was a sufficient amount present for the necessary assimilative processes. He found the chlorophyll content of the hypocotyl to be rather more than half the amount contained in a single foliage leaf. He also found that in this species there are about five stomata to every square millimeter of hypocotyl surface.

Further investigations are necessary to determine whether other members of the genus Bruguiera possess haustorial cells arising from secondary endosperm, as was found to be the case in *Rhizophora mucronata*, although they do not appear to be of equal importance in the latter plant. In the myrsinaceous species studied, *Ægiceras majus*, the hypocotyl pierces the testa but does not enter the fruit, and the formation of endospermal haustoria takes place only in the region of the placentæ.

The paper here noticed is one of the many important contributions to botanical knowledge which have emanated from the Buitenzorg botanic garden. (Cf. BOTANICAL GAZETTE, **19:** 74. 1894.—G. H. HICKS.

[7] Ueber das Aufblühen der Gräser. Bot. Zeitung **38:** 432. 1880.

A contribution to the physiology of the genus Cuscuta.

G. J. Peirce brings out in the *Annals of Botany* for March, the results of his experiments on this interesting group of parasites, which has at various times received so much attention. It will be remembered that in a previous article Mr. Peirce described the origin, structure, and development of the haustoria of several species of Cuscuta and other parasites.[1]

It is found that Cuscuta during the process of attachment to a host plant or a support has two distinct methods of forming coils. In one case by circumnutation and geotropism the steep loose coils characteristic of the majority of twining plants are formed. In the other, closely wound tendril like coils are formed as a result of the irrito-contractility of a region of the growing tip of the stem. When a seedling starts from the soil, into which its roots scarcely penetrate, it begins a rapid circumnutation from left to right, and the region near the growing tip becomes very sensitive to contact of an upright plant or some body which will furnish nutrition. It forms around such objects two or more close coils by its power of irrito-contractility. On the inner side of these coils the growth of haustoria is induced by contact. The completion of the development of the haustoria and their penetration of the host, however, depends on the supply of nourishment derived from the host. The haustoria are able to pierce the tissues of the host by the mechanical pressure of the coils, and by the chemical action of the enzymes secreted by the haustoria, prehaustoria, and cushion cells.

After Cuscuta has thus become attached to a host, the stem below the point of attachment dies away, it climbs upward a short distance by the ordinary twining coils when it again forms another series of contractile coils with haustoria. After the first attachment is made, the growing tip becomes sensitive to contact with any solid object, but not to gelatine or liquids. By horizontal revolution on the clinostat the parasite loses the power to form the characteristic twining coils, since it is freed from geotropic influences. During this treatment it also become non-sensitive to contact, and does not regain its normal condition for several hours. This latter fact is unexplainable in the light of our present information on reactions to contact (unless it were possible that the jar-

[1] On the structure of the haustoria of some phanerogamic parasites. Ann. Bot. **7**: 291. 1893.

ring of the clinostat has acted as a repeated stimulus, thus exhausting the power of response). The Cuscuta is placed in the limited category of twining plants which have the power of irrito-contractility. The comparison of its phenomena of this character, with those exhibited by tendrils are not always happily made, while throughout the paper the author seriously confuses climbing and twining plants.

Cuscuta is not markedly hydrotropic and exhibits only a weak heliotropism. The latter power is not in any way correlated with the amount of chlorophyll present, which varies inversely with the amount of nutriment received from the host. The high development of the power of movement and special senses of this parasite renders it a formidable enemy to succulent plants, whose only means of defense against it are firmness of cortex, size, and the possession of poisonous juices.

In places the article calls for the closest scrutiny of the context to bring out the meaning. The large mass of detail presented makes this obscurity in part unavoidable.—D. T. MAC DOUGAL.

BRIEFER ARTICLES.

Germinating seeds in sawdust.—Germinating seeds in sawdust is not so commonly practiced, we believe, as it might be, owing to the fact that sawdust frequently has a detrimental effect on root growth.

In our intercourse with other teachers of botany we have often been reminded of this fact; and in many instances we have observed the roots of germinating plants grown in this medium to be in a very unhealthy condition.

For the benefit of those who use sawdust in germinating seeds, and have experienced difficulty in obtaining satisfactory results, we offer the following suggestions.

The difficulty lies in the selection of the sawdust. Care should be taken to select sawdust which contains no tannin, as this is the element which causes abnormal root growth. Roots grown in sawdust containing tannin show a reddish coloration, are crooked, and are very much reduced in size. In testing a number of different kinds of sawdust, we have found that that taken from the varieties of oak and chestnut should be avoided, since these woods contain tannin in sufficient quantities to cause the tannin poison. On the other hand, sawdust obtained from the conifers has no detrimental effect whatsoever to root growth.

The sawdust taken from hemlock, which is noted for containing large quantities of tannin in its bark, did not cause the tannin poison; neither did a water solution of the sawdust give a tannin reaction when tested with a solution of molybdate of ammonia in concentrated ammonium chloride. This is due to the fact that the tannin is located in the bark in this species and our sawdust was from heart-wood. That the abnormal appearance of roots grown in chestnut or oak sawdust is caused by tannin can be readily shown by saturating any sawdust suitable for normal growth with a 1 per cent. solution of tannin. If one has an unknown variety, or a mixed sawdust in which the elements are not readily recognized, a water decoction can be prepared and a portion of the same tested for tannin by one or more of the well known tannin tests.

In our opinion, no germinating medium is better than sawdust, as clean straight roots for class study or for experimental purposes can be readily obtained. We have never experienced difficulty with any sawdust which failed to give the tannin reaction, and during the past year we have used the same sawdust continually without changing.

We prefer a rather coarse sawdust to a fine one for general purposes. The seeds should be sown in well drained pots and watered at least once a day. It must not be forgotten, however, that roots germinating in sawdust or even in moist air or water, are slightly different from those grown in earth. The roots of sawdust cultures present characteristics in their growth which are closely allied to roots grown in moist air.—G. E. STONE, *Amherst, Mass.*

Note on the development of a filamentous form of Protococcus in entomostracan appendages. (WITH PLATE XXX.)—While examining a collection of *Sphæroplea annulina* brought in during the latter part of April, a very curious object was discovered under the microscope which at first sight might well have been mistaken for a new algal form. It proved to be fragments of the appendages of some entomostracan, presumably a Branchipus, in which a colony of Protococcus had obtained a foothold and was apparently in a very thriving condition.

The plant was an aquatic form, the collection having been made from submerged meadow lands. It agreed in every respect with the description given by De Toni of *Protococcus infusionum* (Schrank.) Kirchn., var. *Roemerianum* (Kuetz.) Hansg. The cells were of a bright green color, globose when free and angular in the crowded portions of the mass; the cell membrane was thin and the contents were homogeneous; the average diameter of the cells was about 10μ.

One fragment of the animal appeared to be a part of the antenna, having two long slender sensory hairs each furnished with one row of spines and a single short hair bearing two rows of spines. A second bit was made out to be probably a portion of the gills. Two lobes were each furnished with a row of hairs about .5^{mm} in length and 17μ in diameter. These hairs were hollow and were very similar in appearance and size to the two long hairs of the antenna. A mass of Protococcus had formed in the broad basal portions of the structures and the cells were so numerous that they were crowded and pressed out of the natural form, becoming angular in outline and giving the appearance of a plate or layer of connected cells. Some of the cells had pushed their way up into the hairs, and undergoing division there had almost entirely filled the hollow lower half of each hair. Every hair then contained from one to four oblong masses of cells each mass being the result of the division of a single cell.

The common form of Protococcus consists of single cells lying together in a loose mass. Instead of this we here have filaments each composed of several cells. This is apparently brought about simply by the conditions in which the plant finds itself. Individual cells were forced up into the hairs whose walls, being transparent, gave op-

portunity for the admission of light, air, and moisture sufficient for the further growth and development of the cells. Division then taking place in the only direction possible from the shape of the enclosed space, a row of cells is formed which resembles in a marked manner filaments of Oscillaria.

This form of growth then affords a striking illustration of the effect of outward mechanical conditions by the modification into a filament, of cells which under normal conditions exist in simple masses or groups.— JOSEPHINE E. TILDEN, *Botanical Laboratory, University of Minnesota.*

EXPLANATION OF PLATE XXX.—Fig. 1, portions of a gill. Only one lobe is figured, the shape of the other being indicated by dotted lines. ×84.—Fig. 2, one of the hairs from the gill. ×450.—Fig. 3, an antenna. ×450.

Northwestern notes.—Lathyrus paucifloras, n. sp.—Rather slender, two feet or more high: stipules broadly lanceolate and halberd shaped, an inch or more long, a third as wide, acuminate above, acute or obtuse below, usually coarsely toothed; leaflets three to six pairs, thickish, oblong-lanceolate or ovate-oblong, strongly apiculate, almost sessile, one or 1½ inches long: peduncles as long as or longer than the leaves, 3- or 4-flowered: flowers purple, an inch long; calyx teeth ciliate, the middle triangular-lanceolate ones twice as long as the upper triangular ones and two thirds as long as the lower lanceolate tooth; pods not seen.—Collected at Roseburg, Oregon, by Thomas Howell, June, 1887 (no. 677); at Wawawai, Washington, by Lake and Hull, June, 1892 (no. 810); and at Snake River Cañon, Washington, by C. V. Piper, May 27, 1893 (no. 1,487). This species has been confused with *L. polyphyllus* Nutt. from which it is distinguished by its few large flowers, fewer thickish leaves, and narrower stipules.

ROSA NUTKANA Presl, var. **hispida,** n. var.—A form of *R. Nutkana* made conspicuous by its strongly glandular, hispid receptacle and glandular calyx, though not otherwise differing from the type.—Collected at Rock Creek, Montana, by Dr. Watson, July 27, 1880 (no. 124); and at Pullman, Washington, by C. V. Piper, June and Sept., 1893 (no. 1,540).

Calochortus pavonaceus, n. sp.—Stems 10–20 inches high, from a small bulbous base, with a bract in the middle an inch or two long: leaves two-thirds as long as the stem, three or four lines wide, strongly involute in the dried specimens: the 1–4-flowered umbel subtended by as many unequal bracts, the longest rather longer than the pedicels; at least one of the pedicels becoming three inches long: sepals ovate-lanceolate, acuminate, glabrous, 1–1½ inches long, strongly flecked with violet within, the thin scarious margin almost transparent: petals

cuneate-obovate, 1¼–1¾ inches long, the margin dentate and long ciliate, tending to become erose at the tip, violet above, yellowish below, with dark markings like the eye of a peacock's feather; gland small, covered with matted yellow hairs, bordered by longer ones, like those on the margin of the petal: anthers oblong, four lines in length, scarcely shorter than the broad-winged filaments: capsule broady elliptic to nearly orbicular, an inch long, with a short, stout beak.—Collected at Pullman, Whitman Co., Washington, by L. F. Henderson, June, 1892 (no. 2,484); and by C. V. Piper, 1893 (no. 1,680); and at Union Flat, Whitman Co., by Lake and Hull, July, 1892 (no. 618). A species near *C. nitidus* Dougl., but well distinguished by its colored petals, and relatively long anthers and short filaments. Mr. Piper's no. 1,681, from Pullman, seems to be *Calochortus macrocarpus* Dougl., though the petals are white, with or without blue markings at their bases. — MERRITT LYNDON FERNALD, *Gray Herbarium, Cambridge, Mass.*

Cross fertilization of petunias.—This series of experiments in cross fertilizing the ordinary purple petunia, were continued until the third generation was obtained. The same precautions against accidental fertilization were used, as described in the previous notes published in this magazine for October, 1892.

The results obtained from the last generation were somewhat more conclusive than from the first, as would naturally be expected, yet the variation in this case was no more than would usually occur in three generations.

The variegated varieties showed the same lack of vitality and productiveness, throughout all the generations. The plants were smaller, weaker, and much less productive than the plain purple in almost every case; but a few plants which seemed as large and as vigorous as the average purple ones bloomed less freely; only a few of these blossoms produced seed capsules, which were always smaller.

The seeds obtained from the first year's experiments were all planted the same day, under exactly the same conditions and their germination was carefully watched and noted every day. No. 1 (self-fertilized), no. 2 (fertilized from a different flower on the same plant), and no. 3 (cross fertilized), were all sowed in the same box with only a thin board partition between, so that there could not have been the slightest difference in their conditions while germinating.

The variegated variety germinated more slowly and less vigorously than the purple; while many of the seeds failed to germinate at all.

On the seventh day a large percentage of no. 3 appeared above ground, while but four of no. 1, and none of no. 2 were up yet. On

the eighth day a few of no. 2 appeared, a few more of no. 1, and many more of no. 3 were above the soil. The seeds all continued germinating at intervals for over two months, though all germinating after the second week were less vigorous than the first.

From the time of germination until the plants died, no. 3 seemed much more vigorous and healthy; while no. 2 stood next, and no. 1 last in rank as over half the plants of the latter died before maturity.

The table below will show some of the chief differences in size, productiveness and vigor of the three series, 1, 2, and 3.

	First generation.			Second generation.			Third generation.		
	1.	2.	3.	1.	2.	3.	1.	2.	3.
Average days germinating	....	....	....	14	14	10	....	....	....
Per cent. germinating	....	....	....	5	15	95	0	10	95
Height, inches, at four months	....	....	....	4	6	7	....	....	....
Height, inches, at six months	....	....	....	10	12	13	....	....	....
No. blossoms	126	95	134	40	70	121	....	....	....
No. capsules ripened	24	21	48	3	37	50	....	....	....
Aver. weight capsule in milligrams	19	27	41	1	16	44	....	....	....
Per cent. blossoms producing seed	19.4	22.5	35.2	9.6	61.6	50	....	....	....

A number of blossoms from each series were accidently destroyed in various ways; but these were subtracted from each number before the averages for seed capsules were made.

It will be seen by this table that the same conclusions may be drawn as before; namely, that self-fertilization tends to weaken the plant, and also to lessen its productiveness; while cross fertilization has just the reverse effects. The crossing of different flowers on the same plant is no doubt better than self-fertilization; though not nearly so good as cross fertilization. There seemed to be a larger percentage of no. 2 producing seed; but the seed capsules were many of them almost empty, while all were much smaller, usually less than one third as large as no. 3. The third generation was planted but no. 1 failed to germinate, so that the plants were not cared for longer.—MINNIE REED, *Kansas Agric. College, Manhattan.*

Trillium cernuum L.—Monstrosities in the genus *Trillium* are not rare, but two unusually singular forms from Canobie Lake, Windham township, N. H., may be worth putting on record.

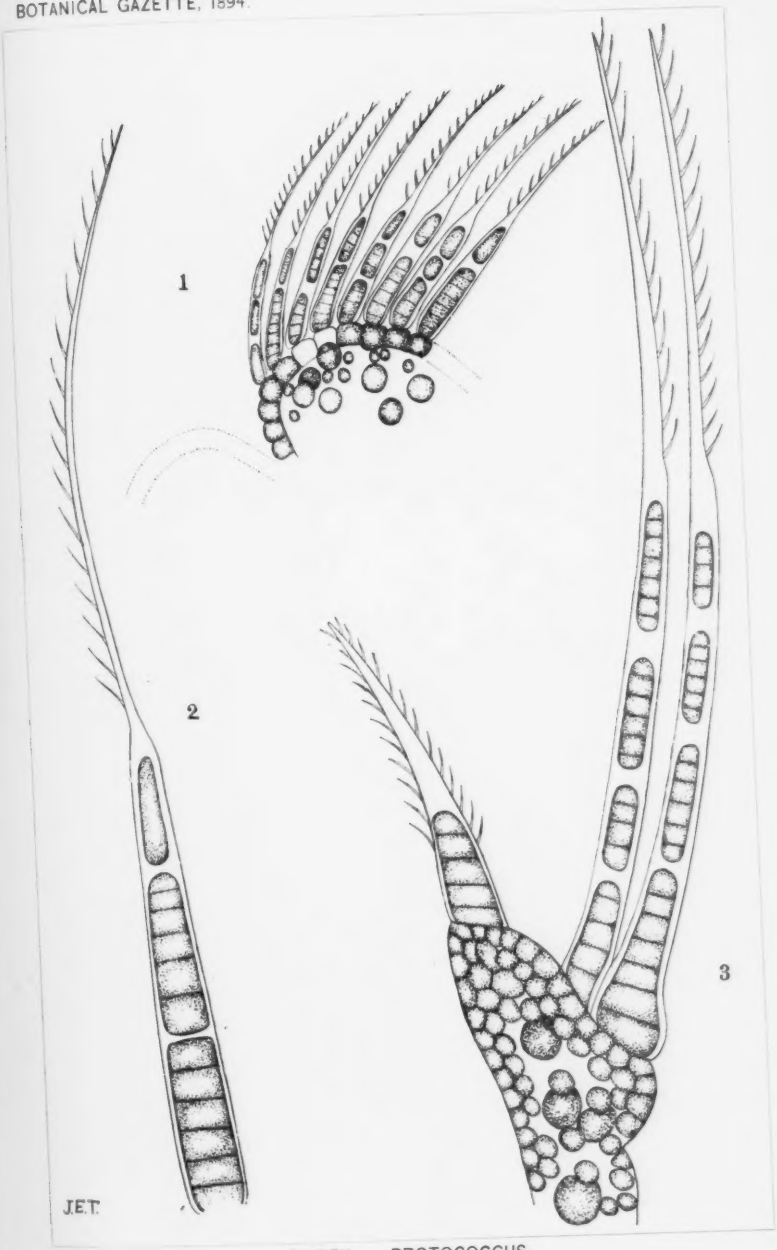
The plants are of the usual size and in each there is the normal whorl of leaves. In one plant, lifted about one inch above that nor-

mal whorl on the stem, are three more whorls of three leaves each set closely together, making a pretty rosette, and above those is the flower erect. Sepals rather larger than common; petals 11' long and 4' wide, with a white stripe running down the center, and a green one on each edge; stigmas four; one of the petals two-parted.

In the other plant a rosette of two whorls; a third abnormal whorl inthis specimen also, but lifted half an inch above the others to the base of the flower. Petals green and white; one stamen abortive; stigmas two. The rosettes pressed and mounted measure in one plant 5^{in} 10' across, in the other 4^{in} 11'.

The upright flowers suggested T. grandiflorum, but the stigmas, distinct and recurved,and the short stamens are perhaps enough to prove the species to be cernuum; moreover, I learn that T. grandiflorum has never been noticed in that vicinity, and that T. cernuum is common where these plants were found. They were collected by a very youthful observer, Miss Anna Dimmock, who writes to me that there were several other similar specimens where she gathered those which she sent here. —MARIA L. OWEN, *Springfield, Mass.*

An abnormal Hepatica.—A peculiar form of *Hepatica triloba*, collected near Boston, was brought to me recently. The peduncle, which is very flat, though not much larger than usual, is doubtless a case of fasciation. The involucre consists of seven green bracts of unequal size, one with a white streak on both sides. A normal flower of nine semi-white sepals is in the normal position. Another smaller flower, of six white sepals, is crowded between the larger flower and the involucre on a short pedicel. This flower has an involucre of three bracts, one green, and two of a variegated green and white color. Both flowers have the usual number of stamens and pistils.—WALTER DEANE, *Cambridge, Mass.*



TILDEN on PROTOCOCCUS.

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EDITORIAL.

THE era of machinery appears to have arrived for American botany. It was probably inevitable whenever physiological studies attracted sufficient attention to take a prominent part in the curriculum. But just the manner and time of its advent could hardly have been anticipated. The elaborate auxanometers, clinostats and other special pieces used in foreign laboratories, made familiar to American botanists through books and journals, described by visitors to Tübingen, Leipzig, Cambridge, Vienna and other famous centers of research, and of which a sample instrument has occasionally been purchased for the general equipment of a laboratory in this country, seemed too expensive and too difficult to obtain ever to become common in America.

At first very simple appliances served the teacher's purpose. The demonstration of transpiration was made by passing a fresh sprig through pasteboard over a tumbler of water, and inverting another tumbler over it, and heliotropism was shown by setting a plant before a window. The need of accurate records led to the adoption of various mechanical methods. Special devices for demonstrating growth were first brought forward. More than a decade ago Professor Bessey's arc indicator became well known, and a few years later the rather elaborate machines devised by Professor Barnes and Mr. Bumpus were figured and described in the journals, and very recently Miss Golden's auxanometer has been described. About three years ago Mr. Swezey described a centrifugal apparatus for studying geotropism, and two years ago Professor Thomas illustrated and described an apparatus for recording root pressure. Other apparatus has from time to time been devised and some of it described in the journals or before societies. But none of these pieces could be obtained in the market. Each laboratory was still obliged to make its own apparatus, or import from foreign makers.

The first pieces of physiological apparatus emanating from an American laboratory, duplicates of which could be purchased, were an auxanometer and centrifugal apparatus originating at Purdue University, and displayed at the Madison meeting of the A. A. A. S. last year. The considerable number of laboratories which have availed themselves within the year of the chance of securing these pieces of apparatus, shows that the plan of offering newly devised apparatus for sale meets with favor.

A circular recently distributed from the botanical laboratories of the University of Minnesota offers the botanical public three ingenious pieces of apparatus: an electrical auxanometer, a registering balance, and a recording apparatus to be used with either of the preceding.

While visiting the botanical laboratories of Wabash College a short time since the writer saw a beautifully made apparatus for recording root pressure, of which duplicates can probably be obtained shortly. There may be other laboratories of research, fortunate enough to command the services of skilled mechanics, already contemplating sharing the results of study and skill with their fellow workers. Certainly we should not be surprised to hear of such, now that the method is fairly inaugurated.

American botanists are an enthusiastic class, and are credited with being well endowed with the proverbial ingenuity of the Yankee, so that having turned their attention to providing their own mechanical devices for studying plants, many compact and efficient designs may be confidently anticipated.

The movement is one to be highly commended. It is only second to the supply of suitable text books in its power to advance the interests of the science of physiology in the higher institutions of learning. It is clearly the precursor to more accurate methods of research in the several lines requiring close measurement. As such instruments become more common, finer methods will prevail, more delicately adjusted machines will be demanded, and more profound studies will be possible. It is one way, possibly the only way, by which American laboratories can hope to attain to a position that will enable them to equal those of Europe in the lines of research requring such apparatus.

Other claims for the wide reaching influence of this movement might be made. It is at least likely to liberalize the prevailing views regarding the requirements for a well equipped laboratory.

CURRENT LITERATURE.

Manual of Vegetable Physiology.

A guide to laboratory exercises in vegetable physiology, the first published for the use of English speaking students, has just been issued from the press of Morris & Wilson of Minneapolis, Minn.[1] This valuable addition to the aids for teaching physiological botany is the outcome of the needs of the flourishing department of physiology in the University of Minnesota. The work is a translation of Oels' *Pflanzenphysiologische Versuche*, published less than a year ago, and intended for the use of middle class schools. The translation has been prepared and printed primarily for the convenience of students in the University of Minnesota, but it has been put into such good shape, and the original text is so admirable that it will prove specially valuable wherever elementary physiology is taught.

The translator has taken great liberties with the Roman-paged prelude to the text proper, but the body of the work has been rendered into English with fidelity, the only change of moment being the substitution of the word "photosynthesis" for that of "assimilation." This change follows from a suggestion by Dr. Barnes, made a year ago before the American Association at Madison, who clearly pointed out the need of a distinctive term for the synthetical process in plants, brought about by protoplasm in the presence of chlorophyll and light. He proposed the word "photosyntax," which met with favor. In the discussion Professor MacMillan suggested the word "photosynthesis," as etymologically more satisfactory and accurate, a claim which Dr. Barnes showed could not be maintained. The suggestion of Dr. Barnes not only received tacit acceptance by the botanists of the association, but was practically approved by the Madison Congress in the course of a discussion upon this point. In the interest of harmony, therefore, even if courtesy be ignored, the word substituted for assimilation, if any were to be inserted, should have been "photosyntax" and not "photosynthesis."

The text is made up of eighty-eight paragraphs of general statements of fact, introducing the experiments, one hundred and twenty-two in number. The illustrations show clearly how the work is to be

[1] OELS, WALTER: Experimental plant physiology; translated and edited by D. T. MacDougal. pp. x + 86. figs. 77. 8vo. Minneapolis: Morris & Wilson. 1894. $1.10.

done. The experiments are well selected, and not difficult to perform. A few are by no means likely to afford the degree of success that the description of the process would indicate; but this comes from inherent difficulties, and to give all necessary precautions would be likely to frighten the beginner from any attempt, which would be worse than to try with but partial success Some of the experiments call for considerable knowledge of manipulation on the part of the instructor. However, it would be difficult to select a more satisfactory series of experiments on the whole, to illustrate the main facts of the science. Moreover, it is not necessary to use the whole series in order to present an acceptable outline, and selections can be made to meet special requirements.

The apparatus required is of the simplest kind, and is not difficult or expensive to provide.

The majority of the experiments are of the qualitative type, and all, even the quantitative ones, are specially designed for beginners, no attempt being made to indicate the precautions or niceties of manipulation required for strictly accurate and authoritative work.

The last chapter, a short one of a page and half, on the relation of plants and animals, does not properly belong to the subject of physiology, but to that of ecology, and its omission would be preferable.

The translator has added a page of equivalents of English and metric weights and measures, and an index to the plants mentioned in the text, for which all students will be grateful.

The printers have done fair work; some minor defects may be overlooked as due to inexperience in book-making. The paper and binding, the latter flexible cloth, are well suited to a laboratory manual.

Minor Notices.

DURING the summer of 1893 the Michigan Fish Commission sent a party to study the flora and fauna of Lake St. Clair. Mr. A. J. Pieters was botanist of the party, and he has now published "The plants of Lake St. Clair" as one of the bulletins of the Commission. The work is based upon that of Magnin in the lakes of the Jura. The flora was found arranged in zones limited by the depth of water, and having certain plants characteristic of each zone, although Magnin's Nupharetum did not exist.

DR. WILLIAM TRELEASE has published an interesting account of Leitneria Floridana, distributed in advance of the sixth annual report of the Missouri Botanical Garden. Mr. B. F. Bush discovered this species in 1892 in the lowlands of S. E. Missouri, the plants being more robust than those of Florida, and associated with other Gulf

species. There seems to be here an indication of the northern extension of the Gulf flora along the deep swamp-lands of the lower Mississippi. Leitneria is also reported from the Brazos in Texas, but there is some uncertainty as to the locality. A remarkable feature of Leitneria is its lightness, being the lightest of all known woods, with a specific gravity of 0.207, while ordinary cork is given as 0.240. Dr. Trelease has made a careful study of the anatomical structure of the stem, and illustrates it by the reproduction of several excellent photomicrographs. Fifteen full-page plates are given.

Mr. Jared G. Smith has published an excellent revision of the North American species of Sagittaria and Lophotocarpus, distributing it in advance of the sixth annual report of the Missouri Botanical Garden. Dr. Engelmann's notes and types served as a foundation for the work. Leaf forms prove very unsatisfactory in classification, and the least variation is found to be in the form and size of the achenium, form of the anthers, pubescence or not of the filaments, relative length of fertile and sterile pedicels, etc. Twenty-two species are recognized, three of which are Mexican, and several new, and much-tangled synonymy is straightened out. Following Buchenau and Micheli, Lophotocarpus is separated from Sagittaria. Twenty-nine full page plates accompany the revision.

The third and last part of Dr. John M. Coulter's "Manual of the Botany of Western Texas" has been issued by the Department of Agriculture. It contains the apetalæ, monocotyledons, gymnosperms, and pteridophytes. The Juncaceæ are contributed by F. V. Coville; Carex by L. H. Bailey; Gramineæ by L. H. Dewey; and Pteridophyta by L. M. Underwood. This completes, in a handy volume, the presentation of the flora of a very interesting region, whose local study was seriously interfered with by the scattered and inaccessible nature of the publications that dealt with its plants. The need of such a work has been attested by the fact of a much larger demand for the earlier parts than could be supplied.

Two "Contributions" have just been issued from the Gray Herbarium; one by Dr. B. L. Robinson (Proc. Amer. Acad. 29: 273–330), and the other by Dr. Robinson and Mr. J. M. Greenman (l. c. 382–394). In the former Dr. Robinson presents a revision of the North American Alsineæ, a continuation of his study of the Caryophyllaceæ. Of the native species Cerastium contains 16 species and varieties, Stellaria 26, Arenaria 46, Sagina 9, and Spergularia (retained instead of Tissa, thus adding to the synonymy of this much vexed group) 11. The rest of the contribution and also the second one are devoted to descriptions of plants from the Pringle collections of 1892 and 1893.

NOTES AND NEWS.

MR. FREDERICK LE ROY SARGENT has a series of articles on the pollination of orchids in the recent numbers of the *Popular Science News*.

MR. T. H. KEARNEY, JR., has been appointed to the curatorship of the Columbia College herbarium, as successor to Dr. Morong, deceased.

BOKORNY has shown experimentally (Archiv. f. Hyg. 20:—.1894) that chlorophyll-bearing aquatic plants are highly efficient in purifying natural waters containing sewerage.

IN THE ANNUAL REPORT of the Connecticut Station for 1893 Dr. W. C. Sturgis gives (pp. 72–111) information about many plant diseases with much helpful matter relating to treatment.

PEACH YELLOWS AND ROSETTE are ably described and discussed by Dr. Erwin F. Smith in a twenty page bulletin from the U. S. Department of Agriculture, no. 17 of the farmers' series.

THE SECOND ANNUAL REPORT of the Ohio Academy of Science is a pamphlet of 52 pages. It includes seventeen short papers or abstracts relating to botany, several of which are lists of Ohio plants.

A SCIENCE CLUB has been organized at Indianapolis, Ind., to promote local interest in scientific subjects and foster good fellowship among resident scientists. Pleasant club rooms have been secured in the Denison Hotel. Mr. John S. Wright is the present secretary.

MATERIAL FOR CLASS use, both alcoholic and dry, and also some living material, can be obtained of the Cambridge Botanical Supply Co. This will prove a great service to many teachers who prefer to buy rather than to collect, or who need some special sorts to complete their list.

IN RECENT NUMBERS of the *Beihefte zum Botanischen Centralblatt* Dr. A. Zimmermann has gathered together the recent literature relating to the plant cell and has presented a summary of the more important contributions. This supplements his work *Die Pflanzenzelle*, and brings information up to date in a most useful manner.

BACTERIUM ZOPFII has been found by Boyce and Evans to be strongly apogeotropic when grown in nutrient gelatine (Centr. f. Bakt. u. Par. 15: 568), and by Beyerinck to be thermotropic (ibid, 799). The last investigator suggests that the sensitiveness to warmth doubtless enables the organism to more readily penetrate the animal body, for it is parasitic upon the domestic fowl.

A CRITICAL NOTICE of Mr. Ganong's paper on the absorption of water by the green parts of plants (this journal, *ante*, p. 136) appears in *Agricultural Science* for March (recently issued), written by Mr. J. Christian Bay. The methods employed are severely criticised, after

which a résumé of the literature of the subject is given, extending from the time of Mariotte and Bonnet to the present.

A NEW YEAST has been found by M. W. Beyerinck (Centr. f. Bak. u. Par., 16: 49–58. 1894) upon Zante currants. It is called *Schizosaccharomyces octosporus*, the genus containing only one other species, an east African form. As the name indicates, it forms eight spores in a cell. It is capable of fermenting glucose and maltose, but not sucrose, lactose or arabinose. It makes but feeble growth in a solution of cane sugar.

VEGETAL PARASITISM among insects is the subject of a paper of nineteen pages and three plates in the Quarterly Journal of Proceedings for April of the Columbus (Ohio) Horticultural Society, written by Prof. F. M. Webster. It includes much valuable personal observation and experiments. A classified list of entomophytes of the families Hypocreaceæ and Entomophthoraceæ enumerates 87 species of fungi with their insect hosts and distribution.

THE CARD INDEX of genera, species and varieties of plants published since 1885, prepared by Miss Josephine A. Clark of Washington, has met with much favor. The series is carefully prepared and can not fail to be of great assistance to any working botanist. All classes of plants are included. There are between one and two hundred cards of fungi in each thousand, and for the convenience of mycologists it has been proposed that these be also issued separately. Miss Clark has consented to this proposition, if a number of mycologists will send in their subscriptions soon. The separate index of fungi will be sold at the rate of $1.75 per hundred cards.

AN EXPEDITION through eastern Africa for the collection of natural history specimens, and to secure photographs, will start from Pretoria, South African Republic, about August 1st, and passing through Matabeleland, the extreme western portion of the East African Portuguese possessions, and along the western coast of Lake Nyassa, will reach Zanzibar after about twelve months. Although all kinds of material of a scientific character will be collected, plants and insects will receive the chief attention. Sets of either of these are offered at $10.00 per century. Those desiring to place orders should address The Kaessner Expedition, care of Imperial German Consulate, Zanzibar, East Africa.

A VERY SATISFACTORY enumeration of the departments into which the science of botany is at present divided (although exceptions may be taken to the nomenclature) is given by Prof. W. F. Ganong in a communication to the New Brunswick Natural History Society, published in the June number of the *Educational Review* of St. John, under the caption "An outline of phytobiology." He makes eleven chief departments, as follows: I. systematic botany, II. phyto-anatomy, III. phyto-morphology, IV. phyto-physiology, V. phyto-pathology, VI. economic botany, VII. botanical geography, VIII. phyto-palæontology, IX. folk botany, X. philosophical botany, XI. phytobiology. The author points out that the amateur can do little to advance the science in departments II, IV and X, that he can do some small service in III, V, VI, VII and VIII; and very important service in I, IX and XI. The object

of the paper is to promote the biological study of Acadian plants by local botanists, but it will interest and benefit other American botanists as well.

BULLETINS FROM THE EXPERIMENT STATIONS for the last month show more than the usual diversity of subjects. Spraying to destroy insects and fungi by S. T. Maynard (Hatch, Mass. no. 25) includes results of the application of Bordeaux mixture upon poplar rust (Melampsora), with two fine plates. Cotton-boll rot by J. M. Stedman (Ala. no. 55) details the study of a new disease of cotton affecting the seeds, lint and bolls, caused by bacteria, with one plate. Second report on rusts of grains by A. S. Hitchcock and M. A. Carleton (Kan. no. 46) gives valuable experimental studies of *Puccinia graminis* and *P. rubigo-veria*. The conclusion is reached that the latter persists through the winter in wheat plants in the mycelial condition, but that the former does not; that rusts of the same species upon different hosts are races which can not be transferred from one kind of host to another, i. e. P. graminis on oats will not infect wheat, etc.; and that spraying for rust on cereals is possible but not practical. Noxious weeds by E. S. Goff (Wis. no. 39) treats of the ten weeds of the Wisconsin weed law, and also of Russian thistle, with illustrations. Some recent Chinese vegetables by L. H. Bailey (Cornell N. Y. no. 67) gives an interesting account of a number of cultivated plants, with their Chinese names, and illustrations.

ACONITUM UNCINATUM is found by David F. Day (*Meehan's Monthly*, 4: 117. Ag 1894) to be an intermittent twiner, as it makes one or two turns about a support, then grows straight for a few inches, when it again makes a turn or two, thus attaining a height of six or seven feet. The fact that the species twines was recorded by Elliott in his sketch of the botany of the Carolinas, 2: 20, but its intermittent character has not before been observed. Plants of this species and of *A. Noveboracense* have been grown by Mr. Day in his garden, and their habits carefully watched. The latter species shows no tendency to twine.